4.0 ENVIRONMENTAL CONSEQUENCES

4.1 Introduction

This section describes the environmental impacts or changes that occurred as a result of DOE, DOE-authorized, or DOE-funded actions that were taken at or nearby the LANL facility during the fire suppression and post-fire periods of the Cerro Grande Fire. Environmental impacts are described and discussed across the various resource areas that were directly, indirectly, or cumulatively affected by DOE emergency response actions. A sliding-scale approach was employed so that environmental resources are discussed at a level of detail commensurate with the level of impacts. The primary beneficial effects of DOE's suppression activities were that the fire was extinguished, no lives were lost, and property and environmental damage was minimized. The primary beneficial effects of the post-fire activities were that LANL quickly returned to operating conditions, burned areas were rehabilitated, and the risk of further damage was reduced to protect operations, property, the downstream environment, and the lives and well-being of workers and residents.

The ROI varies across resource areas but generally includes the entire area affected by the Cerro Grande Fire. Section 2 of this SEA describes DOE actions taken; Section 3 describes the LANL and ROI environment before and after the fire. The information presented in Sections 2 and 3 is the foundation for understanding and evaluating the environmental impacts of DOE emergency response actions discussed in Section 4.

The methodologies used to determine impacts in this chapter differ from typical NEPA documents because of the emergency nature of the actions actually undertaken by or on behalf of DOE. For the most part, impacts are based on events or activities that have already occurred and not on planned or proposed actions. For example, the acreage affected by constructing the flood retention structure in Pajarito Canyon (10 ac [4 ha]) is not an estimate but the actual area disturbed. Therefore, impacts to certain resources such as the Pajarito Canyon floodplain, have already occurred and are simply reported as fact in their appropriate sections. However, the potential impact of this disturbance on other media, such as biological resources, is estimated based upon many variables in addition to habitat disturbance.

In addition to reporting or describing impacts that have already occurred, efforts were made to assess the level or significance of the impacts. Although 10 ac (4 ha) of Pajarito Canyon floodplain were disturbed by constructing the flood retention structure, the amount of disturbance was minimal in comparison to the amount of benefit the structure provides in terms of human health and safety. Adherence to existing and emergency permit conditions (e.g., air emissions and storm water runoff) were also factored into estimating the actual or potential impacts of response actions. Numbers of actual sites affected (e.g., cultural resources and PRSs) and the degrees of damage were also provided to quantify the extent of certain impacts. Actual numbers of workers injured were provided, but potential radiation doses to workers and the public were estimated based on limited monitoring data.

In this SEA, impacts are addressed as occurring from activities either during the fire suppression or the post-fire time period. Short-term impacts are defined as those occurring within the next five years; long-term impacts are those occurring beyond this five-year period. Furthermore, impacts are addressed as either occurring across the entire facility or within defined watersheds at LANL. The major contributors to impacts during the fire suppression were fire road or firebreak construction and tree cutting. The major contributor to impacts during the post-fire period was the construction or modification of various flood control structures, contaminated sediment removal, and demolition actions taken in certain canyon areas at or near LANL. In general, DOE actions had localized or limited individual adverse impacts and were designed to protect life and property from the effects of the fire and subsequent soil erosion and surface water runoff caused by seasonally heavy rainfalls. In this respect, the actions had a significant positive cumulative impact at LANL and within the ROIs for most resources.

4.2 Land Use

4.2.1 Effects of Fire Suppression Activities

Land uses in the region and at LANL are expected to return to post-fire status within three to five years. Fire suppression involved the removal of trees within LANL to reduce fuel around buildings, roads, and utilities. A new, temporary use of the Cache Facility site was established during the fire suppression period. A short-term rest camp for firefighters and support crews was established within the Cache Facility site. This rest camp was about 58 ac (23 ha) in size.

4.2.2 Effects of Post-fire Activities

No long-term changes in land use in the region or at LANL have occurred as a result of post-fire activities taken by DOE. Post-fire activities involved the additional removal of hazard trees within LANL. This activity enhanced the safety and security buffer zones around certain burned portions of LANL, particularly along SR 501. The 58-ac (23-ha) rest camp site returned to its prior use as a LANL buffer zone. Certain recreation trails within LANL were closed and will remain closed until cleanup and flood mitigation measures are completed and vegetation is reestablished.

4.2.3 Cumulative Effects

The ROI for consideration of cumulative effects on land use encompasses the communities of Los Alamos and White Rock, the National Forest and National Park areas surrounding LANL, and LANL. Fire suppression and post-fire activities in these areas had short-term adverse effects on the use of many recreation trails in this area. A temporary additional residential area has been established by the Federal Emergency Management Agency in Los Alamos townsite until former residential properties can be cleared and rebuilt, which may take an additional 18 to 24 months. No long-term adverse cumulative effects on land use at LANL or in surrounding areas are expected.

4.3 Geology and Soils

4.3.1 Effects of Fire Suppression Activities

None of the fire suppression activities included actions that could have significantly affected local geology. Fire suppression activities that could result in soil erosion include disturbance from construction of firebreaks, access roads, and staging areas, and from backfires, and slurry drops. Firebreak construction and other activities involving heavy machinery on mesa tops could have exposed mineral soils and resulted in increased soil erosion. In addition, these activities could have had some temporary adverse effects on slope stability.

Other fire suppression activities such as slurry drops and water drops would have caused minor soil erosion.

4.3.2 Effects of Post-fire Activities

Permanent roads and firebreaks have been properly stabilized and are being maintained. New temporary roads, firebreaks, and staging areas have been stabilized and rehabilitated by raking and seeding actions. No significant soil erosion is anticipated as a result of the construction of these temporary features. Contour raking, straw mulching, contour tree felling, construction of log erosion barriers, installation of straw wattles, aerial seeding, and hydromulching are treatments that have been implemented during the post-fire period to stabilize soils and reduce soil erosion and surface runoff effects from burned and bladed areas. Hazard trees have been felled throughout LANL to alleviate immediate threats to lives and property. Of these activities, only the soil stabilization treatments are intensive or extensive enough to cause significant soil erosion. The expected result of the watershed treatments, however, is to stabilize soils and reduce surface runoff, in some cases by more than 50 percent after two years and 70 percent after three years (BAER 2000). These measures will also enhance slope stability, which is a beneficial geological impact.

DOE implemented BMPs to protect PRSs and other areas. Rehabilitation techniques similar to those used within the rest of the area burned in the Cerro Grande Fire were used with similar effects. No significant soil erosion was observed as a result of these activities. However, significant beneficial impacts are expected from the revegetation of slopes and watersheds, which will significantly reduce soil erosion.

4.3.3 Effects of Post-fire Activities by Watershed

Table 4.1 shows the approximate area of watershed treatments for LANL/DOE property as a whole and by watershed.

TABLE 4.1—*Watershed Treatment Areas (ac/ha)*

	Watersheds					
Treatment	**Water**	**Pajarito**	**Mortandad**	**Los Alamos**	**Sandia**	**Total LANL area treated**
seed/rake/mulch	135/55	840/340	163/66	0	0	1,196/484
hydromulch	85/34	265/107	91/37	0	0	441/176

Seven engineered actions for the purpose of addressing soil erosion and storm water control were implemented (Table 2.5, page 2-20). The four largest engineered structures are those in the Los Alamos Canyon and Pajarito Canyon watersheds: the flood retention structure in Pajarito Canyon, a low-head weir in Los Alamos Canyon, reinforcement of the Los Alamos Reservoir dam, and the Anchor Ranch Road reinforcement and spillway construction.

Although substantial soil erosion could occur from the newly disturbed backfill around these structures, soil stabilization activities performed in these areas should reduce adverse soil erosion impacts. However, the greatest beneficial impact will be that these structures will protect downstream lives and property and will prevent or minimize downstream impacts of soil erosion, the potential downstream transport of sediments and contaminants, and potential flooding.

The other three engineered activities listed in Table 2.5 (page 2-20) affected very small land areas and are predicted to have insignificant adverse impacts on soil erosion, especially since they involve soil stabilization activities (beneficial impacts) at culverts within canyon road crossing areas along SR 501.

4.3.4 Cumulative Effects

The following paragraph discusses soil impacts by fire suppression and post-fire activities. The ROI for soil issues is defined as the entire area burned by the Cerro Grande Fire. Soil erosion and flooding processes are highly dependent on runoff conditions throughout the entire watershed, not just the area within the boundaries of LANL.

Cumulative impacts to geology and soils are assessed by evaluating the impacts of the implementation of the Cerro Grande Fire BAER Plan on neighboring properties together with DOE activities at LANL. The implementation of emergency watershed protection and rehabilitation treatments proposed in the BAER and ERT plans would not result in any adverse effect on the burned area or areas downstream. Implementation of these plans would be expected to result in a significant cumulative beneficial effect by reducing the extent and intensity of potential erosion, potential downstream transport of sediments and contaminants, and potential flooding. DOE activities will, therefore, have a cumulative significant beneficial effect in combination with BAER activities on geology and soils.

4.4 Water Resources

4.4.1 Effects of Fire Suppression Activities

No major effects on water quality are anticipated as a result of the construction of fire access roads, firebreaks, or staging areas. Fire suppression actions that could affect surface water quality and quantity include disturbance from the construction of firebreaks, access roads, and staging areas. Such construction exposes mineral soil and increases the potential for soil erosion and for increases in total suspended solids (TSSs) in surface waters.

No major effect on surface water quality is anticipated as a result of slurry and water drops during fire suppression. The fire-retardant slurry used on the Cerro Grande Fire was an ammonium polyphosphate solution, which is a common agricultural fertilizer. The slurry contains small amounts of other chemicals including sodium ferrocyanide as a rust inhibitor. The U.S. Department of Transportation does not classify sodium ferrocyanide as a hazardous material. Both ammonium and sodium ferrocyanide, however, can be toxic to aquatic organisms if applied to surface waters. Within the LANL burned area, only Los Alamos and Sandia Canyons contain perennial surface water. The sections of these canyons that contain surface water did not burn and are not known to have received direct slurry drops. In laboratory tests, mortality associated with ferrocyanide occurred within the first 48 hours and high levels were evident after 96 hours (Little and Calfee 2000). No information, however, on the long-term effects of ferrocyanide in the environment is available. Ammonium applied to soils is rapidly converted to nitrate or volatilized to the atmosphere. Nitrates from slurry could potentially find their way into the surface or groundwater systems. However, an increase in nitrates is expected following fire because of the conversion of organic nitrogen in vegetation to ammonium and subsequent microbial conversion to nitrate. To distinguish the source of an adverse increase in nitrates in the LANL area would be very difficult. Nitrate from slurry drops is most likely to be assimilated by plants or microorganisms and is unlikely to contaminate groundwater. None of the other previously described fire suppression activities is anticipated to have major effects on perched groundwater resources.

4.4.2 Effects of Post-fire Activities

No significant adverse effects on surface water quality and quantity are expected from post-fire watershed treatment actions. The focus of this assessment of hydrologic impacts from post-fire activities on water resources is the LANL portion of the burned area. Permanent roads and permanent firebreaks created during the fire suppression period have been properly stabilized and are being maintained. New temporary roads, firebreaks, and staging areas have been stabilized and rehabilitated by raking and seeding activities. These actions are expected to reduce the soil erosion potential, thereby protecting surface water quality. Contour raking, straw mulching, contour felling, log erosion barriers, straw wattles, aerial seeding, and hydromulching are watershed treatments that have been implemented during the initial post-fire period to stabilize soils and reduce surface storm water runoff from burned areas. Hazard trees have been felled throughout LANL to alleviate immediate threats to life and property. Of these activities, only the soil stabilization treatments are likely to be intensive or extensive enough to potentially affect surface water quantity and quality. Soil stabilization treatments are expected to reduce storm water runoff and erosion from burned areas by more than 50 percent within two years and 70 percent after three years (BAER 2000). Storm water runoff and concentrations of TSSs are expected to be lower than they would be downstream from untreated burned areas. Revegetation is, therefore, expected to have a significant beneficial effect on both water quality and quantity as a result of DOE taking these actions.

In addition to watershed treatments, USACE installed various engineered structures to control storm water flow and hold back sediment and debris. Since these engineered structures are designed to reduce sediment transport and flooding damage, the overall effect on surface water quantity and quality should be a significant beneficial impact. The SWPP Plan for these projects was designed to minimize the potential for reduction in surface water quality from disturbance of soils and sediment during construction activities. Minor contaminant transport off-site from LANL could occur during flood events in some canyon areas. This is not expected to have a significant adverse effect on water quality. Actions taken by DOE to reduce the potential for sediment and contaminant transport should have a beneficial effect on surface water quality.

No adverse effects to the quality or quantity of perched groundwater or springs are anticipated as a result of post-fire actions. Watershed treatments could lead to increased infiltration of precipitation and subsequent shallow groundwater recharge. If this happens, there is the potential for increased discharge via springs. Recharge will be negated, in part, by the seeded grasses and resprouting vegetation that will transpire soil water. Flood retention structures designed to temporarily retain and slowly release water could lead to increased short-term groundwater recharge depending on the location of the structure, the substrate, and the amount of water retained temporarily.

4.4.3 Cumulative Effects

The ROI for consideration of cumulative effects of water resources issues encompasses the entirety of the watersheds that cross LANL, from the headwaters in the Jemez Mountains to Cochiti Reservoir. Non-DOE actions that may affect surface water and groundwater quality and quantity include fire suppression and post-fire actions taken by the BAER Team on Forest Service- and Park Service-administered property in the watersheds above LANL. Essentially, the ROI actions and the potential effects are the same as those discussed for LANL in this assessment. The impact of the non-DOE actions in the ROI has been to reduce storm water runoff, including sediment and debris, onto LANL and other properties. Together with LANL's actions, these measures are expected to cumulatively reduce runoff into the Rio Grande and result in a beneficial effect on water resources including overall water quality. These effects include reducing potential downstream flooding and TSSs.

4.5 Floodplains and Wetlands

4.5.1 Effects of Fire Suppression Activities

Because of the small area of floodplain disturbed, there was no significant adverse effect to LANL floodplains as a result of fire suppression activities. No wetlands were affected. Fire suppression on LANL was very similar to activities conducted on nearby Forest Service land. Many of these activities took place within floodplains, and a few activities took place within wetlands. These activities had a small adverse effect on floodplains where vegetation removal and ground-disturbing activity occurred. Indirect effects to floodplains include a reduction in the capacity of the floodplains to retain water and an enhanced likelihood of soil erosion.

During fire suppression activities, five new fire roads or breaks were cut across the floodplains. The firebreak activities disturbed less than 1.0 ac (0.4 ha) of the floodplains at LANL. As a result of these activities, there was some vegetation loss that will lead to a slight increase in soil erosion. The vegetation loss from firefighting activities was minimal. There were no new fire roads or breaks placed in wetlands. As a result, no wetlands were affected by fire suppression activities.

4.5.2 Effects of Post-fire Activities

Following the fire, there were seven major storm water control projects and numerous minor construction projects within the floodplains. As a result of these actions, approximately 20 ac (8 ha) of floodplain were directly disturbed or permanently altered. These storm water controls will protect downstream floodplains and wetlands from erosion that would occur with the anticipated higher than normal storm water runoff. The effect of this construction is significantly beneficial. For example, the estimated 10-fold (Table 3.2, page 3-7) increase in runoff for the six-hour, one-hundred year flood event in some of the watersheds will be reduced to near normal levels in Pajarito Canyon with the addition of the flood retention structure. Additional storm water controls in the Los Alamos Canyon, Pajarito Canyon, and other watersheds will also reduce the amount of floodplain and wetland disturbance compared to untreated watersheds.

Adverse effects to floodplains occur when vegetation is removed and soil is disturbed or removed. These actions reduce the capacity of the floodplain to retain water and increase the likelihood that the floodplain soils will be eroded away. Wetlands may be adversely affected by vegetation removal and by erosion or sedimentation that kills vegetation or changes the hydrology of the wetlands. Either erosion or sedimentation could result in a decrease in size of the wetlands and loss of wetland habitat for various species. Actions that moderate peak flows from storm water runoff, reducing flows to near normal levels, and that reduce the potential for sedimentation or erosion, on the other hand, have a beneficial effect on both floodplains and wetlands.

Los Alamos Canyon Watershed

The suite of activities in the Los Alamos Canyon watershed is likely to result in the significant beneficial preservation of floodplains, wetlands, and riparian areas. These activities would limit flooding and sedimentation despite disturbance of a few acres of floodplains.

Several actions taken in the Los Alamos Canyon watershed are designed to reduce the amount of runoff and sediment transport. Water was emptied from the Los Alamos Reservoir to improve silt and debris retention and to reduce the danger from the transport of debris down the canyon. Although construction activities disturbed up to 1 ac (0.4 ha) of the floodplain, these actions will reduce runoff, silt, and debris that could be transported onto LANL from the upper watershed.

Near the confluence of Los Alamos Canyon and DP Canyon, contaminated soils were removed to avoid potential contamination movement off-site. The action reduces the

amount of contaminants available to be moved downstream, which is a beneficial impact. No wetlands were affected by this action.

Roads in lower Los Alamos Canyon were improved with the addition of gravel to the drainage crossings. This action did not adversely affect floodplains or wetlands.

The weir in Los Alamos Canyon is designed to dissipate storm water flow rate energy and trap sediment in the event of flooding. A small area of floodplain (about 1 ac, 0.4 ha) was disturbed by the construction. A SWPP Plan was implemented to control soil erosion. No wetlands were lost during construction of the weir. Very little soil erosion is expected from the disturbance around the construction site that would not be trapped by the weir itself. Wetlands may develop upstream of the weir as it fills with sediment and retains moisture.

At TA-2 and TA-41, building demolition and the installation of fences, rock gabions, and concrete barriers, as well as road grading activities disturbed about 2.0 ac (0.8 ha) of floodplains, a small adverse effect. The overall beneficial effect of the projects is to greatly reduce potential damage from runoff and erosion compared to untreated burned watershed.

Pajarito Canyon Watershed

Post-fire activities in this watershed had both adverse and beneficial impacts on floodplains and wetlands. Several actions taken in the Pajarito Canyon watershed are designed to reduce the effects of storm water runoff and sediment and debris transport. The largest and most significant project in the watershed is a flood retention structure constructed in middle Pajarito Canyon. In substantial flood events, water, sediment, and debris that is held back behind the structure could cause sedimentation of the upstream floodplain. Water may back up temporarily during a severe flood event (i.e., a six-hour storm with a return rate of once in one-hundred years) up to about 2,000 linear feet (600 linear meters) from the structure. The area upstream from the flood retention structure is likely to begin to develop wetland characteristics and vegetation over several years. Although about 10 ac (4 ha) of vegetation were removed or disturbed by construction, no wetlands were affected. The flood retention structure will provide beneficial protection of downstream floodplains and wetlands from erosion.

Less than 1.0 ac (0.4 ha) of floodplain was disturbed by road reinforcements at Two Mile and Pajarito Canyons along SR 501 and at Two Mile Canyon and Anchor Ranch Road. Additionally, culvert replacement and cleaning at SR 501 within Pajarito Canyon disturbed less than 1.0 ac (0.4 ha) of floodplains. No wetlands were affected by these actions.

Implementation of the storm water control projects is expected to greatly reduce the amount of sedimentation in downstream wetlands compared to untreated canyons. There should be a significant beneficial impact on the downstream wetlands and floodplains.

Two projects, the enlargement of culverts in lower Pajarito Canyon, one about 0.25 mi (0.4 km) downstream from TA-18 and the other at SR 4, resulted in removal of about 1.5

ac (0.6 ha) of wetland vegetation composed primarily of willow trees. This wetland habitat was part of the habitat area for the southwestern willow flycatcher at LANL. The habitat removed, however, was not confirmed nesting habitat and was of marginal quality for use by southwestern willow flycatchers. Wetland vegetation is likely to regenerate over the next several years if the area is not silted in or scoured away by floodwaters.

Other Watersheds

Activities in the Sandia Canyon watershed had negligible effects on floodplains and wetlands. In the Sandia Canyon watershed, there was only one action taken to reduce the effects of storm water runoff. Concrete encasement and gabions were added to an existing RLW pipeline that crosses Sandia Canyon to stabilize side slopes and prevent erosion. Only an area the width of the line (3 ft [0.9 m]) crossing the canyon bottom was disturbed in the upgrade of this structure. Less than 1.0 ac (0.4 ha) of floodplain and no wetlands were affected. The effect to the overall floodplain in Sandia Canyon was negligible.

Sediments in three existing sediment traps, covering about 0.5 ac (0.2 ha), in the lower portion of Mortandad Canyon were excavated. This action resulted in minor soil disturbance within the floodplain. No wetlands were affected. Wetlands could develop in the sediment traps in the future, although none have developed there in the past.

Activities in the Water Canyon watershed had slight adverse effects on floodplains and no adverse effects on wetlands. In upper Water Canyon, the SR 501 crossing was improved to reduce the potential of road damage from water retention behind the road banks. Just to the west of SR 501 in Water Canyon, less than 1.0 ac (0.4 ha) of wet meadow was buried by fire debris during the June 28, 2000, flood event, before the crossing was improved. The small amount of work performed in this area had no adverse effect on the wetland. Less than 1.0 ac (0.4 ha) of floodplain was disturbed, a slight adverse impact.

4.5.3 Cumulative Effects

Actions conducted by DOE and others within the ROI have resulted in a loss of a few acres of wetlands, but additional wetlands may be created behind the flood retention structures. The overall effect of these actions is to protect wetlands downstream in the ROI from serious erosion or sedimentation, which is a significant beneficial impact.

Storm water runoff in the aftermath of the Cerro Grande Fire could increase the size and extent of floodplains at LANL and elsewhere in the ROI, depending on the location, amount, and duration of rain events. Although the fire suppression and post-fire actions in the floodplains have disturbed floodplains and have resulted in increased localized runoff, these adverse changes are minor compared to changes caused by the fire. Cumulatively, the flood retention structure, storm water controls, and soil erosion control measures taken by DOE and other agencies will have significant beneficial impacts. These actions will moderate peak flows of storm water runoff and reduce sediment transport throughout the ROI compared to taking no action to reduce storm water effects.

Cumulatively, actions will help to maintain downstream wildlife habitat as well as to protect property and operational functions at LANL and real property in White Rock.

4.6 Biological Resources

4.6.1 Effects of Fire Suppression Activities

The DOE's fire suppression activities resulted in transient and long-term effects to biological resources. The clearing of about 130 ac (52 ha) understory plants and the removal of trees associated with the fire suppression activities temporarily displaced local wildlife. Deer, elk, birds, and small mammals would be expected to have left the sites. This displacement may have ranged from a few days to several weeks, depending on the species involved. However, wildlife rapidly returned to the affected areas and, with an anticipated return of plant cover over the next several years, wildlife use and diversity could be expected to return to pre-fire conditions. Use of the areas affected by fire suppression activities (for nesting, foraging, and cover) by some bird species may be expected to decline long term on a local basis while other species would remain unchanged. Fire suppression activities are not likely to have disturbed federally-listed T&E species at LANL; nor are they likely to have had any effect on state-listed species. Only one pair of birds that are federally listed as threatened were known to have been present at LANL at the time of the fire. Their nesting area was burned and they fled the area in front of the fire. This pair of birds has since returned to their nesting site area.

4.6.2 Effects of Post-fire Activities

The DOE's post-fire construction of storm water control and retention structures and implementation of soil erosion control measures produced an array of biological effects. These effects ranged from transient to long term; some of these effects may be considered beneficial and some adverse. In the long term, the major beneficial effect is the protection of wildlife habitat from further degradation from flooding and the restoration of vegetation on burned areas within LANL. Additionally, the activities taken at LANL will potentially reduce the transport of contaminants into wildlife habitats.

In general, protection of habitat from flood damage will have a beneficial effect on federally-listed T&E species and other wildlife. However, destruction of core nesting and roosting potential habitat in Pajarito Canyon due to construction of the flood retention structures will have a minimal long-term adverse effect on the quality of the potential Mexican spotted owl habitat and the associated partially burned AEI. Minor removal of cliff face area (up to about 75 ft [12.5 m] from the canyon bottom and about 50 ft [15 m] in width) on both sides of Pajarito Canyon also occurred during the construction of the flood retention structure and associated road. This is a permanent adverse effect to that potential habitat area. Trees in a stressed condition that are within the retention structures pooling area may die if repeated flooding events occur over the same growing season. The Pajarito Canyon flood retention structure removed up to about 5 percent of the Mexican Spotted Owl AEI and will result in wildlife habitat fragmentation for game animals. However, this construction is not expected to have an adverse effect on individual Mexican spotted owls or designated critical habitat for the species. New Mexico State-listed T&E species are not likely to have been affected by

post-fire activities since they have not been found in the areas where actions had taken place on LANL.

The clearing of about 20 ac (8.0 ha) understory plants and the removal of trees associated with the post-fire emergency measures had transient as well as long-term effects on local wildlife. The general disturbance and removal of vegetation resulting from implementing the post-fire activities may have temporarily displaced local wildlife. For example, deer, elk, birds, and small mammals would be expected to have left the project sites. This displacement could range from a few days to several weeks, depending on the species involved. Wildlife, however, rapidly returned to the affected areas and, with an anticipated return of plant cover over the next several years, wildlife use and diversity could be expected to return to pre-fire conditions. Use of the affected areas (for nesting, foraging, and cover) by some bird species may be expected to substantially decline on a local basis while other species would remain unchanged. Although draining Los Alamos Reservoir displaced all the fish in the reservoir, many fish were removed from the reservoir and relocated before it was drained. Draining the reservoir also results in a temporary loss of 2.2 ac (0.9 ha) of surface water for wildlife use.

4.6.3 Cumulative Effects

Habitat changes from the fire suppression and post-fire emergency actions within the ROI will primarily result in significantly beneficial, long-term impacts to biological resources. Examples of these beneficial changes include decreased soil erosion, restoration of understory vegetation, and a minimization of contaminant transport within habitats. The most severe adverse effect to habitats will be a result of elimination of both understory and overstory vegetation over about 13 ac (5.2 ha) during construction of the flood retention structure, the low-head weir, and the Mortandad Canyon sediment trap together with the resulting fragmentation of those habitats.

Restoration of understory vegetation by reseeding over the ROI is likely to be the greatest beneficial impact to habitat areas (Photos 4.1a and 4.1b). Because the seed mixture being used for reseeding contains two nonnative annual species, these species may dominate the initial colonization of the burned area for the first growing season. Perennial species in the seed mix will dominate in the burned areas in the subsequent year(s) as the nonnative species are expected to reseed themselves only for one or two years. Vegetative composition and abundance in the burned area will be different than it would have been without the reseeding effort. However, the protection from erosion and runoff provided by the reseeding effort is considered a significant beneficial effect. In the long term, suitable native plants will return to a balanced condition through normal plant succession.

4.7 Climatology, Meteorology, and Air Quality

4.7.1 Effects of Fire Suppression Activities

The use of ground and air equipment for fire protection and suppression produced emissions of criteria air pollutants. Because of the closure of LANL and the evacuation of the townsite, normal vehicle emissions of criteria air pollutants were greatly reduced.

PHOTOS 4.1a and 4.1b—*Understory Regeneration in Seeded and Mulched Areas, August 3, 2000*

Emissions from fire protection and fire suppression ground equipment were roughly 20 percent to 80 percent of emissions from typical LANL vehicle traffic for a two-week period, which is a negligible adverse effect on air quality and less than that expected under typical LANL operating conditions.

4.7.2 Effects of Post-fire Activities

The primary air quality effects from post-fire activities are from construction activities and contaminant disturbance and removal. These activities, except for operation of the concrete batch plant, are exempt from permitting requirements of applicable regulations. The adverse effects on air quality were of short duration—ranging from a few days to a few months.

Ground-disturbing construction and excavation of PRSs were responsible for temporary localized increased concentrations of particulate matter, including some radioactive particulates (Table 4.2). Doses to the nearest offsite receptor (e.g., residences, schools, or offices) from airborne radioactive emissions associated with work in PRSs were estimated not to exceed 0.1 mrem. Heavy equipment used for post-fire construction activities produced carbon monoxide (about 23 tons/21 t), hydrocarbons (about 2 tons/1.8 t), oxides of nitrogen (NO_x) (about 1 ton/0.9 t), and other criteria pollutants. These emissions are estimated to be less than one percent of expected annual emissions from typical LANL vehicle traffic.

Air emissions were estimated for an emergency permit to operate the concrete batch plant used in construction of the flood retention structure. Particulate emissions were estimated at less than 3.0 pounds per hour. The batch plant was permitted to operate continuously for up to 90 days. An equipment malfunction caused emission to increase to an estimated 7.0 pounds per hour over a three-day period. After construction of the flood retention structure was complete, the batch plant was disassembled and removed. The effect to air quality from the operation of the batch plant was a temporary slight adverse impact.

TABLE 4.2—*Radiological Emissions from Construction Activities in Areas with Contaminated Soils*

Activity	Air Emission (curies [Ci])								Total Soil Excavated (tons)
	Am-241	Pu-238	Pu-239,240	Cs-137	Sr-90	U-234	U-235	U-238	
Los Alamos Canyon weir	4.78E-07	N/A	3.11E-07	1.63E-06	3.57E-07	N/A	N/A	N/A	13,000
Excavation of sediments in Mortandad Canyon sediment traps	7.10E-06	2.36E-06	8.78E-06	1.49E-05	1.20E-06	5.38E-07	3.34E-08	5.04E-07	380
Excavation of contaminants in Los Alamos Canyon	2.39E-06	1.37E-07	5.68E-06	2.02E-04	4.15E-05	N/A	N/A	N/A	1,000

Source: Hurtle 2000

4.7.3 Cumulative Effects

Air emissions from post-fire activities in the ROI were temporary and localized. When all sources of emissions were combined, they did not constitute a significant adverse effect on regional air quality.

4.8 Visual Resources

4.8.1 Effects of Fire Suppression Activities

The principal effect on visual resources resulting from fire suppression activities at LANL was the cutting of firebreaks and fire roads. These features interrupt the landscape with linear scars but are typically not visible from publicly accessible areas. This is a temporary adverse effect to visual resources at LANL.

4.8.2 Effects of Post-fire Activities

The various construction activities had minor adverse effects on visual resources at LANL. New firebreaks and fire roads constructed during the fire suppression period that are not needed for long-term fire protection have been revegetated. Over a period of years, the vegetation will blend with the surrounding area and the revegetated area will become less noticeable. Increased suspended particulate matter from construction and heavy equipment use may have resulted in decreased visibility within small areas for short periods of time but would be expected to quickly return to normal conditions. Storm water retention and flood control construction activities such as road bank reinforcement along SR 501 and SR 4 at Los Alamos Canyon are highly visible and introduced non-natural elements (construction vehicles, rock gabions, etc.) into otherwise minimally disturbed areas. The visual disruption associated with heavy equipment use was limited to the construction period. The visual effects of the rock weirs and similar features will continue until they are removed or until native vegetation covers them. Other construction activities, such as the flood retention structure in Pajarito Canyon and the associated concrete batch plant, are located in areas that are generally out of sight of major viewing locations such as public roadways. Runoff from burned areas will cause ashy, black sediment to be deposited in stream channels and behind the storm water control structures. These deposits will be visible for a period of a few years and will be a slight adverse effect to visual resources (Photo 4.2). The primary beneficial effect of the post-fire activities is the restoration of understory vegetation through reseeding. Vegetation recovery will reduce the contrast between the burned and unburned areas.

4.8.3 Cumulative Effects

The primary beneficial cumulative impact of activities within the ROI to visual resources is the restoration of understory vegetation, which will reduce the contrast between burned and unburned areas. The adverse effects to visual resources are small-scale and localized and do not constitute a cumulatively adverse effect.

PHOTO 4.2—*Charcoal-laden Sediment Deposited by Runoff from Burned Areas*

4.9 Cultural Resources

4.9.1 Effects of Fire Suppression Activities

Most ground-disturbing activity areas such as firebreaks, fire roads, and staging areas were partially or completely surveyed by professional archaeologists before the actions occurred; no cultural resource sites were identified in the surveyed areas and, thus, none were affected. In the early days of the Cerro Grande Fire, however, three prehistoric archaeological sites at TA-49 were adversely affected by leveling a staging area in conjunction with the construction of the rest camp. One cultural resource site was destroyed, two others were damaged. Although this is considered an adverse effect, these three sites constitute less than one percent of the total number of LANL archaeological sites.

4.9.2 Effects of Post-fire Activities

Post-fire activities resulted in adverse effects to some historic properties but also reduced the likelihood that other cultural properties would be adversely affected by erosion, a beneficial impact.

Ground-disturbing activities have the potential to adversely affect cultural resources sites. UC cultural resources specialists reviewed post-fire activities, including raking and seeding projects and major construction projects. Any cultural resources in the areas of effect were demarcated in the field with flagging tape to prevent inadvertent impact by

project activities. No adverse effects to archaeological sites occurred as a result of ground-disturbing activities. At Anchor Ranch Road, a trench constructed to temporarily divert water from a pond to the drainage channel while the culvert under the road was being replaced affected an historic pond. The effect from this activity is not considered to be adverse.

The complex of historic buildings at TA-2 was affected by the decision to remove these structures from the floodplain. The structures removed as part of DOE's post-fire actions in Los Alamos Canyon (Section 2.3.2.1) were scheduled for decontamination, decommissioning, and demolition before the Cerro Grande Fire. That schedule was accelerated to prevent the structures from becoming water-borne debris during a major runoff event. The two significant historic structures affected by the removal action are the rod storage facility (TA-2-4) and the cooling tower (TA-2-49). The cooling tower had been documented and DOE had consulted with the State Historic Preservation Office (SHPO) before the Cerro Grande Fire. Although UC cultural resources specialists documented the buildings before they were dismantled, the removal of the buildings is considered an adverse effect to historic properties.

Effects to TCPs from the full range of post-fire actions are likely but there is insufficient information about the locations of these sites to analyze the impacts fully at this time. Consultation with the Accord Pueblos, as noted in Section 1, was incorporated into the ERT process. In some cases, activities were modified in response to Native American concerns.

The extensive erosion and storm water control efforts have had a beneficial effect on most cultural resources. In particular, these measures have decreased the likelihood that other cultural resources would be adversely affected by erosion. At TA-18, the historic Pond Cabin and at TA-2, the historic Omega-West Reactor were surrounded with concrete barriers and sandbags to prevent damage from debris carried by storm water runoff. Construction of the flood retention structure upstream will provide the Pond Cabin additional protection from flooding.

4.9.3 Cumulative Effects

Together with BAER Team rehabilitation measures on Santa Clara and San Ildefonso Pueblos land and on burned areas of Santa Fe National Forest, DOE erosion and storm water controls are expected to further reduce downstream erosion and sedimentation that could adversely affect cultural resources. Therefore, these erosion and storm water control measures will have a significant beneficial effect on prehistoric and historic cultural resources and TCPs that are located in, or downstream from, areas burned by the Cerro Grande Fire.

4.10 Utilities and Infrastructure

4.10.1 Effects of Fire Suppression Activities

The fire suppression activities had a beneficial effect on water, gas, and electric utilities at LANL by minimizing damage to utilities and infrastructure. The lowest level of

electricity usage ever recorded, which was about 35 megawatts of power, was imported through the Norton and Reeves Power Lines during this period. Normal LANL operational use is about 55 megawatts. At the LANL Sanitary Wastewater Treatment Plant, the lowest volumes during this period were about 60,000 gal. (227,400 l) per day. Normal sanitary wastewater volume is 300,000 to 350,000 gal. (1,137,000 to 1,326,500 l) per day. Total water usage during May 2000 was about 50.4 million gal. (191 million l). The previous month's water usage was about 31.6 million gal. (116 million l). Two temporary water supply stations, "pumpkin tanks," were brought in to LANL and supplied water for water-tanker helicopters. Helicopter pilots used these 3,000-gal. (11,400-l) tanks to fill the helicopters' buckets. Gas service was cut off to TAs 22, 40, 15, 8, 9, 16, 33, and 39 and Bandelier National Monument during the fire. About 30 mi (48.3 km) of new or upgraded access roads were bladed, although most of these were of temporary nature so effects to infrastructure were also temporary in nature.

4.10.2 Effects of Post-fire Activities

Beneficial impacts on utilities and infrastructure occurred from the installation of flood control and flood retention structures, such as the Pajarito Canyon flood retention structure, the low-head weir in Los Alamos Canyon (Photo 2.16, page 2-26), and the TA-18 steel diversion wall with backfill. Flood control concrete barriers were placed around the bases of all power poles located within potential flood areas.

The post-fire activities to control storm water runoff have a beneficial effect on facilities, use of roadways, and other infrastructure such as communication and security systems. Benefits include improved access to both utilities and infrastructure from additions of new firebreaks and improved maintenance of existing firebreaks in and around utility lines and facilities. Post-fire hazard tree removal activities have also improved access to buried water and gas lines as well as electric and communication lines that are located in areas that were overgrown with vegetation. These areas are particularly difficult to reach to perform maintenance or, in the event of an emergency, to perform repairs. Hazard trees in forested areas bordering roadways were removed, which in turn improved visibility and reduced the potential for vehicular collisions with wildlife and forest debris on roadways.

4.10.3 Cumulative Effects

The ROI for consideration of cumulative effects on utilities and infrastructure encompasses the communities of Los Alamos and White Rock, the National Forest and National Park areas surrounding LANL, and LANL. Overall implementation of these activities will have a beneficial effect on utilities and infrastructure by reducing the extent and intensity of potential flooding damage downstream of the burned area.

4.11 Socioeconomic

4.11.1 Effects of Fire Suppression Activities

No substantial changes to either the local or regional populations or economies are expected as a result of fire suppression and post-fire mitigation activities. Short-term increases in employment (about 180 UC subcontractors) occurred at LANL.

4.11.2 Effects of Post-fire Activities

UC employees and subcontractors worked substantial amounts of overtime during this period. Under an interagency agreement, the USACE and their subcontractors worked onsite for about four months. Congress appropriated about $342 million for DOE's post-fire activities. Some of these actions will occur over the next two years and will be the subject of additional NEPA compliance review.

4.11.3 Cumulative Effects

The ROI for consideration of cumulative effects on socioeconomics encompasses the communities of Los Alamos and White Rock and northern New Mexico. Fire suppression and post-fire activities in these areas cumulatively will result in a short-term unstable labor market resulting from changes in the demands for specialized construction workers primarily that will be brought on-site for limited duration and will leave at the completion of the job. Additional appropriations by Congress for rebuilding the Los Alamos Community will also provide a beneficial infusion of money into the local economy during this three-year period (2000 to 2003).

4.12 Noise

4.12.1 Effects of Fire Suppression Activities

Actions authorized by DOE during the fire suppression and the post-fire response periods of the Cerro Grande Fire had a minimal effect on the types of noise and the typical noise levels found at or in the vicinity of LANL. During the conduct of fire suppression activities, the types of noise and increased noise levels resulting from DOE-authorized actions were similar to noises produced from routine operations at LANL or in the surrounding area, the Los Alamos County Airport. Activities conducted for fire suppression generated noise from the use of emergency response and firefighting equipment such as trucks, helicopters, and airplanes. This equipment operated on a continuous basis during daylight hours at LANL. Emergency response and firefighting vehicles also operated around the clock. Helicopters and airplanes were not used to fight the fire at night. In addition, earthmoving equipment and chain saws generated noise during the construction of 473 ac (189 ha) of firebreaks, fuelbreaks, and new or improved access roads. The combined effect of these activities resulted in minor and localized increases in noise levels. Work at a particular location was generally completed in a matter of hours or a few days and noise generation subsequently ceased.

Fire suppression activities that generated noise or increased noise levels occurred for about two weeks during May 2000 until mid-August. During most of May, the

workforce at LANL and the residents of Los Alamos had been evacuated and were not exposed to any noise associated with fire suppression. The removal of vegetation during the fire suppression period on 100 ac (40 ha) of LANL land could result in a moderate reduction in the ability of certain areas to attenuate noise from routine operations. This could expose workers in the vicinity of these areas to a slightly higher noise level from any operations that infrequently or routinely produce elevated noise levels. Because of the distance between the burned areas at LANL and most residential areas, vegetation removal conducted during the suppression period should not increase the noise levels experienced by most members of the public so impacts should be negligible. As vegetation recovers, ambient noise levels should return to pre-fire levels.

4.12.2 Effects of Post-fire Activities

The types of noise and the changes in noise levels that occurred in conjunction with the post-fire activities were similar to those that occurred during the fire suppression activities. Various vehicles, earthmoving equipment, helicopters, and airplanes continued to operate in and around LANL on a more frequent basis during daylight hours than what occurred before the fire. This equipment was used to finalize fire suppression, move supplies, reseed areas, and generally rehabilitated burned areas. Various vehicles and earthmoving equipment operated around the clock to construct flood control structures in remote areas or canyon drainages within the boundaries of LANL, Los Alamos County, or nearby pueblos. Chain saws were used to remove burned trees or to clear areas for flood control structures.

The types of noise and levels of noise from these post-fire response actions were typical of on-going construction activities and maintenance operations routinely performed at LANL. Most of these activities were conducted in remote areas where there were few, if any, permanent LANL workers and no nearby residences. The workers performing the actual work were exposed to noise, but all exposures were maintained within safe levels consistent with construction health and safety plans. Vehicular traffic noise increased in proportion to the increase in the number of construction related vehicles. Vehicle noise on public roads associated with this period was concentrated in July and August 2000. Vegetation thinning occurred in additional locations in and around LANL during this period that would further reduce the ability of the environment to attenuate noise. However, because of the remote location and short duration of most activities and the expected recovery of the vegetation, noise levels have quickly returned to background levels and impacts should be minimal.

4.12.3 Cumulative Effects

The cumulative adverse effects on noise levels from activities that occurred in response to the Cerro Grande Fire on DOE and adjacent federal- and local government-administered lands within the ROI for noise resources were relatively minor and temporary. Noise producing activities were similar in nature and in duration to those occurring on DOE lands only, but also affected residential areas. These activities occurred during both the Cerro Grande Fire suppression period and the post-fire period in burned, remote, and residential areas primarily to the north, west, and south of LANL. Most burned or remote areas were not located near residential areas. During the fire

suppression period, the local population was not affected because they had been evacuated. During the post-fire period, routine activities at LANL, the Los Alamos County Airport, and in residential areas around LANL resumed and contributed to the cumulative effects on noise levels. An increase in the use of the Los Alamos County Airport was noticeable. However, most post-fire activities either occurred in remote areas or did not exceed typical noise levels for local residential areas. Aircraft use over LANL and nearby areas is usually restricted. During the fire suppression and post-fire activities this restriction was lifted. Fire suppression activities and post-fire activities involving aircraft use, such as aerial application of mulch, were of a minor and temporary nature. The air space restriction over LANL was reinstated on August 1, 2000.

4.13 Environmental Justice

4.13.1 Effects of Fire Suppression Activities

Environmental justice impacts occur when there are disproportionately high and adverse human health or environmental effects on minority or low-income populations that could result from the actions undertaken by DOE. The fire suppression actions had no disproportionately high and adverse human health or environmental effects on minority and low-income populations.

4.13.2 Effects of Post-fire Activities

Post-fire activities will have a beneficial effect on environmental justice issues as the risk of soil erosion and flood damages are significantly reduced to downstream communities due to LANL post-fire activities. Air and water quality monitoring stations at LANL were repaired or replaced. Ongoing air, water, soil, and produce monitoring data will continue to be collected and effects observed.

4.13.3 Cumulative Effects

Implementation of fire suppression and post-fire flood and erosion control measures within the ROI are expected to have a cumulatively beneficial effect in terms of environmental justice. Actions taken by DOE and others are expected to reduce the extent and intensity of potential flooding downstream for the Pueblos of Santa Clara and San Ildefonso, the towns of Española, Los Alamos, and White Rock, and other small communities in this area. This is a beneficial impact to TCPs and other properties of low-income and minority populations.

4.14 Human Health

4.14.1 Effects of Fire Suppression Activities

Actions authorized by DOE during the performance of fire suppression activities relative to the Cerro Grande Fire had a minimal to moderate adverse effect on emergency response worker (i.e., worker) health and a potentially significant beneficial effect on public health. Non-emergency response workers at LANL were either evacuated or excluded from areas where fire suppression occurred. Therefore, there were no adverse health effects on non-emergency response workers from DOE-authorized actions.

During the fire suppression period, workers were exposed to smoke and fire from burning vegetation, structures, and PRSs. Workers also faced hazards associated with the thinning of vegetation, construction of firebreaks, helicopter and fixed-wing aircraft operations, and emergency response vehicle traffic. Chemicals used during the fire suppression period (e.g., foam and slurry) were either considered to be of low toxicity or were used in a manner so as to limit worker exposures. Fire suppression activities occurred on a continuous basis for about two weeks in May 2000 until the Emergency Operations Center at LANL returned to routine operations. About 2,000 workers were directly or indirectly involved in fire suppression activities during this period.

Members of the public living in the vicinity of LANL had been evacuated during this period and were therefore not directly affected by DOE-authorized actions taken in response to the fire. However, authorized actions taken during this period prevented the spread of fire to additional residential areas located north and east of LANL and helped to contain the extent of the fire on San Ildefonso Pueblo lands. In addition, the sharing of emergency response resources among DOE, Forest Service, Park Service, Los Alamos County, and nearby Pueblos contributed significantly to preventing injury or loss of life to members of the public and further damage to personal property from the fire.

Only relatively minor injuries or exposures to workers were actually recorded or estimated to have occurred during the fire suppression period. Fire suppression activities resulted in four recordable fire related worker injuries ranging from a fractured heel to smoke inhalation during May 2000. All injured workers are expected to recover fully. Fire suppression activities, including wildfire, facility, and PRS firefighting, and firebreak construction exposed workers to minimal amounts of radioactive materials. Preliminary worker dose estimates indicate that individual worker doses did not exceed 0.2 mrem and were generally much less than this (LANL 2000g). DOE regulations allow for annual worker doses up to 5,000 mrem. Since worker doses were far below allowable annual doses (about 0.004 percent of the allowable worker dose), no adverse health effects to workers from radiation exposures should result from fire suppression activities.

Members of the public living in communities outside of Los Alamos County received minimal radiation doses (much less than 1.0 mrem) from smoke associated with the Cerro Grande Fire (LANL 2000b). Typical background levels of radiation produce annual doses to members of the public living in these areas of about 350 mrem. Therefore, the total contribution to the public dose from the Cerro Grande Fire is about 0.3 percent of the typical background dose. It is unlikely that any activities authorized by DOE to suppress the fire resulted in a dose to the public. However, any activities that might have indirectly contributed to public dose would have resulted in a dose that is much less than the total contribution made by the fire. Since the total dose to the public from smoke associated with the fire is minimal, any public doses associated with fire suppression activities that produced smoke would also be minimal.

4.14.2 Effects of Post-fire Activities

Effects on worker health that resulted from the post-fire response period were less than or similar to those that occurred during the fire suppression period. Workers were not

exposed to smoke from an active fire during this period but continued to be exposed to hazards associated with the removal of vegetation, construction activities, helicopter and fixed-wing aircraft operations, and vehicle traffic. Other activities made use of typical construction materials or materials that are not considered to be hazardous to workers or the public when used according to directions. A total of about 1,800 workers were involved in DOE-authorized post-fire activities.

Post-fire activities resulted in one reported worker injury from a fall associated with managing inventories for aerial seeding operations. The injured worker is expected to fully recover. Post-fire activities, including PRS and soil stabilization activities, flood control structure construction, and facility cleanup, exposed workers to minimal amounts of radioactive materials. Preliminary worker dose estimates indicate that individual worker doses did not exceed 1.2 mrem and were generally much less than this. DOE regulations allow for annual worker doses up to 5,000 mrem. Since worker doses were far below allowable annual doses (about 0.024 percent of the allowable worker dose), no adverse health effects to workers from radiation exposures should result from post-fire activities.

In general, members of the public were not directly affected by post-fire activities conducted at LANL because of the distance between these activities and residential areas. Increases in vehicular traffic associated with construction activities resulted in some congestion on publicly accessible roads in and around LANL, particularly during July and August 2000. No radioactive materials were released off-site as a result of post-fire activities. Wood removed from construction sites that was determined to be free of contamination was released for public use. Any contaminated or potentially contaminated material was retained for appropriate management and disposal.

Indirectly, members of the public benefited significantly from post-fire activities. PRS and soil stabilization activities and the construction of flood control structures reduced or eliminated the risk to residential areas, including San Ildefonso Pueblo, of a catastrophic flood crossing LANL and reaching these populated areas. In addition, the potential for a large amount of contamination moving off LANL and reaching populated areas or the Rio Grande was also reduced.

4.14.3 Cumulative Effects

The cumulative adverse effects on worker and public health from activities that occurred in response to the Cerro Grande Fire on DOE and adjacent federal- and local government-administered lands were relatively minor. Workers that fought the fire on LANL lands and off-site were exposed to a greater amount of smoke- and fire-related hazards than those involved with LANL-only activities. However, no serious injuries or fatalities were reported. Since members of the public had been evacuated from Los Alamos County, the fire suppression period did not result in any serious health impacts on the general public.

Cumulative adverse health effects to workers and the public during the post-fire period were similar to those encountered during the fire suppression period. Although health

hazards to workers and the public from exposure to smoke and fire were practically eliminated during this period, work with potentially hazardous equipment (e.g., earthmoving equipment, axes, wood chippers) increased. Members of the public returned to their communities but were generally excluded from areas where post-fire activities were conducted. No serious injuries or fatalities to either workers or the public were reported during this period.

The cumulative effects of fire response actions on DOE and nearby lands also had a significant beneficial effect on LANL non-emergency response worker health and safety and members of the public. DOE facilities in flood prone areas were either protected from potential flooding or operations and workers were relocated to higher ground. The construction of flood control structures and related actions also reduced the amount of sediments and potential contaminants that could be transported off of LANL into nearby communities or the Rio Grande. These structures also reduced the potential for floods to damage personal property downstream from LANL and other affected communities and pueblos.

4.15 Environmental Restoration and Waste Management

4.15.1 Effects of Fire Suppression Activities

There were no effects on environmental restoration and waste management from fire suppression activities during the fire suppression stage.

4.15.2 Effects of Post-fire Activities

One MDA required extensive fire suppression efforts to control a subsurface smoldering fire. BMPs for the 91 PRSs have been completed. These sites and their specific BMP requirements are listed in Table 2.4 (page 2-19; LANL 2000h). As of July 21, 2000, 47 accelerated actions were either in progress or had been completed.

BMPs have been used throughout LANL to assure that stabilization is achieved. Channels and floodplains containing contaminated sediments have been stabilized by contamination removal or installation of catchment basins in order to minimize the potential for off-site transport of potential contaminants beyond pre-fire runoff rates. Impacts to existing streams and drainages have been minimized. BMPs were implemented in an ordered fashion to achieve the greatest reduction in contaminant transport risks from the most likely events (summer flooding) (LANL 2000h).

Performing BMPs on 91 PRSs and initiating 47 accelerated cleanup actions will have a significant beneficial impact on limiting the spread of contaminants within and outside of LANL. The BMPs listed in Table 2.4 (page 2-19) will prevent or reduce contaminated soil erosion and runoff from PRSs directly affected by the Cerro Grande Fire. In addition, these PRSs have been stabilized so that a long-term cleanup strategy can be implemented without the potential for conditions at these sites to deteriorate or for these sites to become larger in size. The accelerated cleanup actions will result in the long-term stabilization, reduction, or removal of contaminants around facilities and in canyon drainages and floodplains at LANL. Contaminant removal, reduction, or stabilization

reduces or prevents the spread of hazardous materials in the environment and facilitates the ultimate DOE cleanup strategy for LANL. In addition, fish and wildlife and residential communities that are located downstream of accelerated cleanup sites in canyon drainages have a reduced probability of being exposed to these contaminants over time.

DOE actions taken during the post-fire period resulted in the generation of additional low-level radioactive and nonhazardous solid waste. The low-level waste that was generated during the post-fire activities (mostly from environmental restoration cleanup) was sent to TA-54, Area G, for disposal. To date, most of the PRSs affected by the fire have been mitigated and BMPs applied. The volume of waste sent to TA-54 was about 1,071 yd^3 (900 m^3), with only a small number of pieces of equipment from TA-41 and no transuranic waste. An additional 595 yd^3 (500 m^3) are anticipated to be stored at TA-54 by the November time period (Personal Communication, Julia Minton-Hughes). About 1,200 yd^3 (912 m^3) of landfill material from building demolitions, 800 yd^3 (608 m^3) of clean fill, and 100 yd^3 (76 m^3) of debris at TA-16 (MDA-R site) are yet to be characterized and disposed of.

The amounts of nonroutine RCRA hazardous waste generated as a result of post-fire activities did not create volumes outside the normal range. These activities also did not result in volumes exceeding LANL's RCRA permit limits for on-site storage. All hazardous materials were accumulated and rapidly shipped off-site for treatment and disposal.

The additional amount of nonhazardous solid waste from LANL that was generated as a result of post-fire activities included material such as clean rubble from the dismantling of buildings and from campsites that were set up at TA-49 for firefighters. Of the 40 buildings either damaged or destroyed by the fire and the 10 structures removed from TA-02, waste volumes of 25,375 ft^3 (761 m^3) for only two structures have been calculated (a trailer in TA-46 and a structure in TA-2). The remaining 48 structures include other buildings and storage structures of varying sizes. The additional solid waste was sent to the Los Alamos County Landfill. Most of the clean building rubble has been sent to TA-60, Sigma Mesa, to an existing rubble storage site. Rubble mostly in the form of crushed rock and dirt from USACE project sites was stockpiled and left on site. The total volume has been estimated as 40,000 yd^3 (30,400 m^3).

4.15.3 Cumulative Effects

The ROI for consideration of cumulative effects on waste includes the communities of Los Alamos and White Rock, LANL, and northern New Mexico. PRSs at LANL were the only PRSs directly affected by the Cerro Grande Fire. Activities occurring on Forest Service lands that are upstream from LANL could have an indirect but cumulative impact on PRSs at LANL. In general, these cumulative impacts would be beneficial because they would reduce the potential for soil erosion and storm water runoff impacts. No other activities within the ROI are expected to have a cumulative effect on PRSs at LANL.

The Northeast New Mexico Regional Landfill near Wagon Mound and Los Alamos County Landfill received the majority of the solid waste that was generated primarily as a result of the cleaning effort of destroyed homes and structures in the Los Alamos townsite. The effect is that the Los Alamos County Landfill will reach capacity sooner than anticipated, probably within the next 10 years. The need for a new regional landfill site to receive solid waste from LANL and the surrounding communities has increased.

4.16 Transportation

4.16.1 Effects of Fire Suppression Activities

Effects on both the regional and internal LANL transportation system as a result of fire suppression were minimal. Some limited-period road closures were necessary during the fire suppression period to prevent access to LANL and to the communities of Los Alamos and White Rock for safety and security purposes. LANL and the townsites were evacuated during the fire suppression period. In addition, road closures enabled firefighters and other emergency personnel to have clear and easy access for moving people and equipment efficiently and safely.

4.16.2 Effects of Post-fire Activities

Effects on both the regional and internal LANL transportation system as a result of post-fire activities were minimal. During the post-fire period, SR 501 was reinforced with concrete at the crossings with Pajarito, Two Mile, and Water Canyons to prevent erosion. This work involved the installation of ACM materials on the upslope side or grading and shaping the downstream side of the roadway or both. Some limited-period road closures were necessary during mitigation activities to support repair work and replacement of culverts. Also, additional road closures were required to allow movement of hazardous materials from areas at risk from potential flooding.

Short-term effects resulted from construction activity primarily along Pajarito Road and SR 4. A total of 400 loads of aggregate material were transported daily along these two roads during July and August 2000 from Albuquerque. This material was transported by 20 trucks during the day bringing in eight loads each and 30 trucks at night bringing in eight loads each for a total of 400 loads each day.

4.16.3 Cumulative Effects

The ROI for consideration of cumulative effects on transportation encompasses the communities of Los Alamos and White Rock, the Forest Service and Park Service areas surrounding LANL, and internal LANL roads. Cumulative effects on transportation did not create a long-term adverse effect on the transportation system at LANL or in this region.

4.17 Summary of Impacts

4.17.1 Impacts at LANL

The actions covered in this SEA encompass a wide range of activities—ranging from fire suppression to major post-fire construction. The individual projects had a series of adverse effects, such as loss of cultural resources and habitat for T&E species and other wildlife, primarily resulting from soil and vegetation removal. The beneficial impacts however, include protection of cultural resources, of substantial areas of floodplains and wetlands, and of government, tribal, and private property. The beneficial effects are expected to outweigh the adverse effects. Table 4.3 summarizes the effects of the fire suppression and post-fire activities.

TABLE 4.3—*Summary of Impacts*

Resources	Fire Suppression	Post-Fire
Land Use	No long-term changes in land use as a result of this effort. Short-term reduction in trees within LANL buffer areas. Temporary expansion of TA-49 Cache Facility for firefighters and support crews.	No long-term changes as a result of this effort. Additional removal of trees by LANL. Certain recreation trails within LANL remain closed until cleanup and flood mitigation areas are complete and vegetation is reestablished.
Geology/Soils	None of the fire suppression activities included actions that could significantly affect the local geology. Activities included construction, firebreaks, access roads, and staging areas, backfires and slurry drops that exposed mineral soil and increased the likelihood of soil erosion.	None of the post-fire activities included actions that could significantly affect the local geology of these activities, only the soil stabilization treatments are intensive or extensive enough to significantly cause soil erosion. However, the expected result of the watershed treatments is to stabilize soils and reduce surface runoff.
Water Resources	No major effects on water or surface water quality is anticipated as a result of fire suppression activities. The fire-retardant slurry used was an ammonium polyphosphate solution. Ammonium and sodium ferrocyanide can be toxic to aquatic organisms if applied to surface waters. Perennial surface water areas of Los Alamos did not burn and are not known to have received slurry drops.	No significant adverse effects to the quality or quantity of surface water or perched groundwater or springs are anticipated from post-fire actions. These actions are designed to control water flow and hold back sediment and debris. Flood retention structures that temporarily retain and then slowly release water could lead to increased short-term groundwater recharge in some locations.
Floodplains and Wetlands	Fire suppression activities had a small adverse effect on floodplains where ground-disturbing activity occurred. No fire roads or breaks were in wetlands, so no wetlands were affected by fire suppression activities.	The construction of seven major and numerous minor storm water control projects resulted in approximately 20 ac (8 ha) of floodplains being directly disturbed or permanently altered. These controls will protect downstream floodplains and wetlands from erosion.
Biological Resources	The fire suppression activities resulted in transient and long-term effects to biological resources. The clearing of about 130 ac (52 ha) temporarily displaced local wildlife. Use of the affected area by some bird species may be expected to decline on a local basis while other species would remain unchanged.	Post-fire activities produced an array of biological effects. In general, protection of potential T&E species habitat from flood damage will be beneficial for T&E species and other species. However, destruction of Mexican spotted owl core nesting and roosting habitats will have a minimal long-term adverse effect.

TABLE 4.3—*Continued*

Resources	Fire Suppression	Post-Fire
Climatology, Meteorology, and Air Quality	The use of equipment for fire suppression activities produced criteria air pollution emissions. Because of the closure of LANL and the townsite, these emissions were roughly 20 percent to 80 percent of typical LANL vehicle traffic for a two-week period—which is a negligible adverse effect.	The adverse effects on air quality from construction activities and contaminant disturbance and removal were of short duration. Doses to the nearest offsite receptor from airborne radioactive emissions associated with work in the PRSs were estimated not to exceed 0.1 millirem.
Visual Resources	The principal effect on visual resources from fire suppression activities was the cutting of firebreaks and fire roads. This is a temporary adverse effect to visual resources at LANL.	The various construction activities had minor adverse effects on visual resources. There was short-term increased suspended particulate matter, new structures in previous minimally disturbed areas, and deposition of black sediment where runoff accumulates behind storm water control structures.
Cultural Resources	The leveling of a staging area in TA-49 destroyed one and damaged two other cultural resource sites. Although this is considered an adverse effect, these three sites constitute less than one percent of the total LANL archaeological sites.	Post-fire activities resulted in adverse impacts to two significant historic structures at TA-02. Although UC cultural resource specialists documented the buildings before they were dismantled, the removal of the buildings is considered an adverse impact. Post-fire activities also created a beneficial impact by reducing the likelihood that other cultural properties would be adversely affected by erosion.
Utilities and Infrastructure	The fire suppression activities had a temporary beneficial effect on water, gas, and electric utilities at LANL by minimizing damage from the fire. About 30 mi (48.3 km) of new or upgraded access roads were bladed, although most of the these were of temporary nature so effects were also temporary.	Beneficial impacts occurred from the installation of flood control and flood retention structures. Major benefits include improved access and maintenance to both utilities and infrastructure at LANL.
Socioeconomics	No substantial changes to either the local or regional populations or economics are expected as a result of fire suppression activities.	No substantial changes to either the local or regional populations or economics are expected as a result of post-fire mitigation activities.
Noise	Actions authorized by DOE during the fire suppression period had a minimal effect on the types of noise and the typical noise levels found at or in the vicinity of LANL. These activities were temporary and during the period when LANL and the townsite were evacuated.	The types of noise from post-fire response actions were typical of on-going construction activities and maintenance operations routinely performed at LANL. Noise levels increased in and around LANL during this period.
Environmental Justice	The fire suppression activities had no disproportionately high and adverse human health on environmental effects on minority and low-income populations.	Post-fire activities will have a positive effect on environmental justice issues as the risk of soil erosion and flood damages are significantly reduced to downstream communities.

TABLE 4.3—*Continued*

Media	Fire Suppression	Post-Fire
Human Health	Fire suppression activities had a minimal to moderate adverse effect on emergency response workers health due to exposure to smoke and fire, firefighting hazards, and exposure to chemicals used. A potentially significant benefit to public health was the prevention of further spread of the fire to additional residential areas.	Effects on worker health that resulted from post-fire activities were less than or similar to those that occurred during the fire suppression period. Workers were not exposed to fire and smoke, but continued to be exposed to other hazards, such as the removal of vegetation, construction activities, helicopter, and vehicle traffic. There was one reported worker injury from a fall associated with managing inventories for aerial seeding operations. The worker is expected to fully recover.
Environmental Restoration and Waste Management	There were no effects (due to no activity) on environmental restoration and risk management from fire suppression activities.	Best Management Practices for 91 PRSs affected by the fire were completed. As of July 21, 2000, 47 accelerated actions were either in progress or had been completed. DOE actions taken during this period also resulted in the generation of additional low-level radioactive waste sent to TA-54 and nonhazardous solid waste sent to approved landfill sites.
Transportation	Effects on both the regional and internal LANL transportation system as a result of fire suppression were minimal. Some limited-period road closures were necessary during this period to prevent access to LANL and to adjacent communities for safety and security purposes.	Effects on both the regional and internal LANL transportation system were minimal. Some limited-period road closures were necessary during this period to support repair work and replacement of culverts, delivery of construction material, and to allow for movement of hazardous material.

4.17.2 Impacts on Watersheds within the ROI

The fire suppression activities at LANL and in the ROI typically had negligible effects on the ROI. The principal adverse effect was soil and vegetation disturbance that damaged a few archaeological sites and could have led to increased erosion and decreased water quality. Most adverse effects were localized and temporary.

The primary impacts of post-fire activities at LANL and in the ROI were beneficial soil stabilization, revegetation, reduction of storm water runoff, and moderation of the expected decline in surface water quality due to the fire.

These impacts are most pronounced when viewed at the level of the watershed. Cumulatively, actions to control storm water runoff and erosion in the watersheds will meet DOE's objective of protecting lives, property, and the environment within the boundaries of LANL and in neighboring areas downstream.

BAER Team rehabilitation treatments were implemented in the upper portions of all three of LANL's major watersheds (Los Alamos Canyon, Pajarito Canyon, and Water Canyon watersheds). DOE treated burned areas within the LANL portions of these watersheds with measures similar to those of the BAER Team. Summer rains have generally been moderate, allowing seeds to germinate without eroding away and producing new understory vegetation, particularly at the higher elevations of the watersheds. The BAER Team rehabilitation measures may be as successful as could be expected during the first growing season after the fire. The LANL portions of the watersheds generally received

less rainfall than the higher elevations and seed germination and understory regeneration may be somewhat less effective than that in the upper parts of the watersheds. Nevertheless, the overall cumulative effect of post-fire treatments has been to encourage vegetation regrowth and limit storm water runoff and erosion.

In the Los Alamos Canyon watershed, DOE's actions contributed to substantially reducing the impacts of storm water runoff. Draining and reinforcing the Los Alamos Reservoir provided about 28 ac-ft of water storage capacity for storm water runoff and allows accumulated water and debris to be released downstream at lower, and less erosive, energies. Installing trash racks and removing structures that could wash away in a severe rain event has reduced the likelihood that water-borne debris will damage downstream property. Removal of contaminated sediments near the junction of Los Alamos and DP Canyons has reduced the likelihood that storm water runoff would carry contaminated sediments offsite. Finally, the construction of the Los Alamos Canyon low-head weir provides a catchment for sediments carried by storm water and would dissipate the energy of storm water runoff that reached that far downstream. The result of these measures, both DOE's and those on neighboring properties, is to reduce the potential damage from storm water runoff, erosion, and contaminant transport and to protect downstream surface water quality, floodplains, wetlands, habitat, cultural resources, and property.

DOE's actions also contributed to substantially reducing the impacts of storm water runoff in the Pajarito Canyon watershed. Reinforcing SR 501 and Anchor Ranch Road not only protects the roads from high-energy storm water runoff but would also allow storm water to pond upstream from the road embankments temporarily and would dissipate the energy of the runoff to some degree. Water reaching the flood retention structure in middle Pajarito Canyon would be retained and released at a reduced energy level. The structure is designed to protect downstream government and private property from damage from high-energy storm water runoff and floating debris. Peak flows would be reduced to near normal and debris would be contained behind the flood retention structure. The trash rack upstream from the flood retention structure would also capture water-borne debris that could damage government facilities. The trash rack and the steel diversion wall upstream from TA-18 serve the same purpose of protecting government facilities from the effects of high-energy storm water flows and water-borne debris. Although culvert cleaning downstream from TA-18 disturbed a small amount of wetland vegetation, the flood retention structure is expected to protect the remaining floodplains and wetlands from excessive runoff. The result of these measures in the Pajarito Canyon watershed, both DOE's and those on neighboring properties, is to reduce the potential damage from storm water runoff, erosion, and contaminant transport and to protect downstream surface water quality, floodplains, wetlands, habitat, cultural resources, and property.

In Mortandad Canyon, DOE cleaned the existing sediment traps to provide catchments for potentially contaminated sediments that might be suspended and transported by higher than normal storm water runoff. Since estimated peak flows for Mortandad Canyon, however, are relatively low, no other engineered storm water controls were implemented. Together with the reseeding and mulching operations, DOE's actions in

the Mortandad Canyon watershed are expected to minimize the likelihood that storm water runoff would transport existing contaminated sediments offsite.

DOE's actions in the Water Canyon watershed consisted of extinguishing the fire at MDA-R and stabilizing the site and reinforcing SR 501. The road reinforcement serves to protect the road from damage from storm water runoff and floating debris. The road would also pond storm water temporarily and dissipate the energy of the runoff. These actions, together with the BAER Team rehabilitation measures in the upper part of the watershed, would reduce the potential damage from storm water runoff, erosion, and contaminant transport and protect downstream surface water quality, floodplains, wetlands, habitat, cultural resources, and property.

DOE's actions in other watersheds primarily consisted of small-scale erosion prevention measures, such as rock gabions and wattles, and various seeding and mulching operations. These actions will reduce storm water runoff damage downstream from LANL. Together with BAER Team rehabilitation measures in other parts of the burned area, the DOE activities will contribute to reversing the effects of the Cerro Grande Fire on surface water quality, wildlife habitat, wetlands, and floodplains. Since the watersheds affected by the Cerro Grande Fire drain into the Rio Grande, the beneficial impact of the combined rehabilitation efforts may include reducing storm water runoff damage to the Rio Grande.